[ABSTRACT]

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A subminiature bone-conduction speaker is disclosed in which a sound wave is transferred to a bone and the auditory nerves of a user are stimulated by the bone vibration. The bone-conduction speaker includes a voice coil secured to a base plate, a magnetic circuit including a yoke, a magnet and an upper plate and oscillating upwards and downwards, and a securing rivet for securing the yoke, a magnet and an upper plate together, and a mastoid positioned on a top surface of the securing rivet and transferring a sound wave outwards. When an electrical current is applied to the voice coil through the coil, a magnetic force generated between the voice coil, the upper plate, the magnet and the yoke is periodically varied as an attractive or a repulsive force, and the periodical variation of the magnetic force causes a periodic movement of the magnetic circuit including the upper plate, the magnet and the yoke on condition that the voice coil is secured to the terminal plate, thereby generating a vibration of the magnetic circuit, so that the vibration is transferred to the contact member and the vibration of the contact member is transferred to the head. Accordingly, the bone-conduction speaker is reduced to such a small size that many electronic appliances, such as a mobile phone, a radio, a headset phone, and a telephone, may include the bone-conduction speaker to thereby generate vibration for recognizing a sound through the bone-conduction auditory sense.

[REPRESENTATIVE FIGURE]

FIG. 2

[SPECIFICATION]

[TITLE OF THE INVENTION]

SUBMINIATURE BONE-CONDUCTION SPEAKER

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a plan view illustrating a subminiature bone-conduction speaker according to an example embodiment of the present invention.

FIG. 2 is a cross sectional view taken along the line II-II in FIG. 1.

<REFERENCE NUMERALS OF MAJOR PARTS IN FIGURES>

10: bone-conduction speaker	11: electrode plate
12: frame	14: base plate
15: central hole	17: recessed portion
20: damper	22: yoke
24: magnet	26: upper plate
30: voice coil	40: protector
50: rivet	52: mastoid
54: film cap	S: inner space
G: gap space	

[DETAILED DESCRIPTION OF THE INVENTION]

[PURPOSE OF THE INVENTION]

[THE FIELD TO WHICH THE INVENTION PERTAINS AND THE PRIOR ART]

The present invention relates to a subminiature bone-conduction speaker, and more particularly, to a subminiature bone-conduction speaker for transferring a vibration to a user's auditory nerves through the user's skull to thereby allow the user to recognize a sound, and of

which a size is reduced sufficiently to be installed in a mobile phone, a radio, a headset phone, a telephone, etc. and sufficiently to prevent the sound from being leaked outside of the device to improve communication security.

Most information is transferred as a wave. For example, a sound recognized by an ear, a light recognized by an eye and an electromagnetic wave received by a television set or a radio system are transferred from a wave source to a destination position by a wave motion without a transition of material between the wave source and the destination position.

The sound wave recognized by an ear is made by a material vibration, and is a kind of special kinetic energy caused by a periodic motion of the atoms of the material. A practical sound instrument makes use of kinetic energy of electrons motivated by current applied thereto. That is, electrical energy applied to the sound instrument is transformed into kinetic energy of the electrons, and the kinetic energy of the electrons is transformed into a sound by a speaker system. The kinetic energy of the electrons causes a vibration of air around the speaker system and the vibration of air is transferred into a user's ear, thereby allowing the user to recognize the sound.

A vibration of air having an auditory frequency (a sound wave) enters into an outer ear through an ear hole, and causes a tympanic membrane to vibrate in accordance with the sound wave. A plurality of auditory cells of an inner ear makes contact with the tympanic membrane, and is stimulated by the vibration of the tympanic membrane. The stimulation of the auditory cells is transferred into the user's brain, and the user recognizes the sound. The auditory frequency of the sound wave ranges from about 20 Hz to about 20 KHz, and a preferred audible frequency of the sound wave for a person's hearing generally ranges from about 125 Hz to about 8,000 Hz. In particular, a frequency of the sound wave for a conversation usually ranges from about 500 Hz to about 2,000 Hz, at which most people

normally communicate with one another. While most people hear all sounds across the auditory frequency range, the hearing impaired can only hear some specific sounds across the auditory frequency range, or cannot hear any sound.

Recently, a bone-conduction telephone has been introduced to help the hearing impaired or the aged to hear all sounds like normal people. The bone-conduction telephone enables the hearing impaired or the aged to communicate with others by using a bone near the ear, such as a user's skull, without any hearing aids such as an acoustic instrument. According to a normal telephone, an electrical signal in a receiver of the telephone is transformed into a sound wave in the ear by a speaker system in the receiver. However, an electrical signal in a receiver of the bone-conduction telephone is transformed into a vibration of a bone around an auricle, and the hearing impaired of which an external ear and/or a mid-ear are/is injured can hear the sound by a vibration transferred through a bone around the auricle, which is widely known as a "bone-conduction auditory sense" as compared with an "air-transfer auditory sense" in the medical world. The air-transfer auditory sense of normal people recognizes a sound as a vibration of air in the ear. The sound recognized by the bone-conduction auditory sense has no noise in itself, so that the hearing impaired can easily communicate with others using the bone-conduction telephone. Besides, although the normal people are in a noisy place, such as a market or a construction site, it is reported that the bone-conduction telephone may improve telecommunication quality without any noise despite the great noise in those types of places.

For example, Korean Patent Laid-Open Publication No. 1996-0007406 discloses a bone-conduction vibrator that enables a fully hearing impaired person, of whom an external ear and a mid-ear is injured, to hear a sound by the bone-conduction auditory sense, and also enables normal people to hear the sound by the air-transfer auditory sense. According to the

bone-conduction vibrator disclosed in the Korean Patent Publication, a mastoid for stimulating the bone around the auricle is secured to an upper portion of the voice coil, and an electromagnetic force caused by an interaction between magnetic fields generated by a magnet and the voice coil oscillates a vibrating plate.

However, the above bone-conduction vibrator has a problem in that a wire connected to the voice coil may be easily cut off due to the vibration of the vibrating plate. Moreover, when downsizing a speaker system including the bone-conduction vibrator, interference by the wire puts limitations in the downsizing of the speaker system including the bone-conduction vibrator, and also reduces output power of the speaker system. In addition, the sound wave generated by the above bone-conduction vibrator may be easily leaked outside of the device, so that a conversation relayed through a communication terminal including the above bone-conduction vibrator may be easily revealed to thereby reduce communication security.

Korean Patent Application No. 1998-64157, which was filed with the Korean Intellectual Property Office (KIPO) on December 31, 1998 by an applicant of the present application, discloses a subminiature bone-conduction speaker system for improving communication security and reducing a size thereof. According to the above subminiature bone-conduction speaker system, a voice coil is secured to a base plate and a magnetic circuit for oscillating upwards and downwards includes a yoke, a magnet and an upper plate. A mastoid is positioned at an upper portion of the magnetic circuit, and transfers a vibration caused by a sound outwards.

However, the mastoid, an adaptor and an eyelet are separate parts of the speaker system, and a bushing for supporting a radial end portion of a damper is installed on an inner sidewall of a frame in the subminiature bone-conduction speaker system; thus, the structure

and manufacturing process for the subminiature bone-conduction speaker system are so complicated that manufacturing productivity of the subminiature bone-conduction speaker system is very low. As a result, there has been a need for improving the productivity by simplifying the structure and the manufacturing process of the subminiature bone-conduction speaker system.

[TECHNICAL OBJECT OF THE INVENTION]

Accordingly, the present invention provides a subminiature bone-conduction speaker for stimulating auditory nerves of a user by a vibration of a bone around the user's ear to thereby allow the user to recognize a sound.

The present invention also provides a subminiature bone-conduction speaker including a voice coil secured to a base plate, a securing rivet by which a mastoid, an adaptor and an eyelet are secured together, and a magnet circuit having a yoke, a magnet and an upper plate and oscillating upwards and downwards, thereby having a simple structure and a sufficiently small size to be applicable to many appliances as well as improving communication security with a less sound leakage.

[CONSTRUCTION AND OPERATION OF THE INVENTION]

According to an aspect of the present invention, there is provided a vibrator for a skeleton telephone and a hearing aid. In the present invention of the vibrator, a conventional vibrating member, such as that which includes a coil and a magnet, is replaced with a piezoelectric device for generating a physical vibration in accordance with an electrical signal corresponding to a sound. As a result, a weight and a size of the skeleton telephone and the hearing aid are reduced because the piezoelectric device is much smaller than the coil and

magnet, thereby improving endurance thereof.

Hereinafter, the preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 1 is a plan view illustrating a subminiature bone-conduction speaker according to an example embodiment of the present invention, and FIG. 2 is a cross sectional view taken along the line II-II in FIG. 1.

Referring to FIGS. 1 and 2, the subminiature bone-conduction speaker 10 according to an example embodiment of the present invention has a cylindrical shape and includes a frame 12 as a sidewall of the subminiature bone-conduction speaker 10. A bottom portion of the cylindrical frame 12 is open and a base plate 14 is inserted to the bottom portion of the cylindrical frame 12. As a modified example embodiment of the frame 12, the base plate 14 may be the bottom portion of the frame 12. An inner space S is defined by the frame 12 and the base plate 14.

A terminal plate 11 is formed on an exterior surface of the base plate 14 and an electrical current is applied to the terminal plate 11 from a power source (not shown), and a coil 13 is secured to the terminal plate 11 by a soldering. The coil 13 extends into the interior of the subminiature bone-conduction speaker 10 through the base plate 14, and is connected to a lower portion of the voice coil 30 that is secured to the base plate 14 in the inner space of the subminiature bone-conduction speaker 10. When the electrical current is applied to the terminal plate 11 from the power source in accordance with a sound, and the electrical current is applied to the voice coil 30 from the terminal plate 11, a magnetic field is varied by an electrical energy in the voice coil 30.

A central hole 15 is formed at a central portion of the base plate 14 so as to control frequency response characteristics of the bone-conduction speaker 10. A bottom portion of

the central hole 15 is closed by non-woven fabrics. A recessed portion 17 is arranged at an end portion of the base plate 14 symmetrically to a portion at which the terminal plate 11 is to be positioned with respect to the central hole 15. A supplemental instrument such as a microphone may be installed to the recessed portion 17.

A circular-shaped protector 40 is detachably installed at an upper portion of the frame 12. A peripheral portion of the protector 40 is adhered to a top surface of the frame 12 by an adhesive. Otherwise, the peripheral portion of the protector 40 may be adhered to the top surface of the frame 12 by a thermal bonding process. An opening is formed at a central portion of the protector 40, and an upper portion of a tubular securing rivet 50 is inserted into the opening. A conventional eyelet and adapter are installed into the securing rivet 50 as one body.

A mastoid 52 is installed to a top surface of the securing rivet 50, and the mastoid 52 makes direct contact with a head portion of a user. The mastoid 52 is formed into a curve at a predetermined curvature in accordance an external appearance of the user, and a colored film cap 54 is inserted into the mastoid 52 for improving the external design thereof.

A stepped shoulder 12b is formed at the upper portion of the frame 12 in a radial direction, and the peripheral portion of the protector 40 is positioned on the shoulder 12b. As described above, the peripheral portion of the protector 40 is adhered onto the shoulder 12b by an adhesive. Otherwise, the peripheral portion of the protector 40 is adhered onto the shoulder 12b by a thermal bonding process. An outer end portion of a horizontal damper 20 is arranged on the shoulder 12b and is interposed between the peripheral portion of the protector 40 and the top surface of the frame 12.

The damper 20 reduces a frequency or an amplitude of a sound wave by dissipating kinetic energy of the vibration, and an inner end portion of the damper 20 is supported by a

body portion 22a of the yoke 22 positioned at a central portion of the bone-conduction speaker 10.

The yoke 22 includes a case for focusing a magnetic flux, and comprises cast iron or cast steel. The yoke is positioned in the inner space S defined by the base plate 14, the frame 12 and the damper 20. The yoke 22 includes a body portion 22a for supporting the inner portion of the damper 20 that extends in a radial direction in the inner space S and an extension portion 22b formed with the body portion 22a as one body and extending downwards.

A circular magnet 24 and an upper plate 26 are positioned in an inside of the extension portion 22b of the yoke 22 in the radial direction. The magnet 24 and the upper plate 26 constitute a magnetic circuit together with the yoke 22. An upper surface of the magnet 24 makes close contact with a lower surface of the body portion 22a of the yoke 22, and a lower surface of the magnet 24 makes close contact with an upper surface of the upper plate 26. A gap space G is defined by sidewalls of the upper plate 26 and the magnet 24 and a sidewall of the extension portion 22b of the yoke 22, and the voice coil 30 is positioned in the gap space G.

The damper 20, the yoke 22, the magnet 24 and the upper plate 26 are sequentially arranged in a vertical direction in the bone-conduction speaker 10 and a joint hole (which is not designated by a reference numeral) is formed through each of central portions of the damper 20, the yoke 22, the magnet 24 and the upper plate 26. The securing rivet 50 is inserted into the joint hole and both end portions of the securing rivet 50 are compressed by a rivet joint, so that the damper 20, the yoke 22, the magnet 24 and the upper plate 26 are jointed together.

The above-mentioned bone-conduction speaker 10 operates as follows.

An electrical current is applied to the terminal plate 11 from the power source, and then is applied to the voice coil 30 from the terminal plate 11 through the coil 13. Then, electrical energy in the voice coil 30 causes variation of an intensity of a magnetic field. That is, when the electrical energy is applied to the voice coil 30, an induced magnetic field is generated between a magnetic field due to the magnet 24 and an electrical field due to the voice coil 30 in the gap space G based on Fleming's left hand rule.

The magnetic force generated between the voice coil 30, the upper plate 26, the magnet 24 and the yoke 22 may be periodically varied as an attractive force or a repulsive force. Because the voice coil 30 is secured to the terminal plate 11, the above periodical variation of the magnetic force from/to the attractive force to/from the repulsive force causes a periodic movement of the magnetic circuit in which the upper plate 26, the magnet 24 and the yoke 22 are formed together with one another. That is, the magnetic circuit oscillates upwards and downwards at a predetermined period, thereby generating a vibration of the magnetic circuit. The damper 20 on the upper surface of the yoke 22 prevents a free oscillation of the magnetic field to thereby generate the vibration at a constant frequency. The vibration is transferred to the mastoid 52 that makes contact with a user's head and is positioned on the top surface of the securing rivet 50, and the vibration of the mastoid 52 is transferred to the bone around the auricle to thereby generate vibration for recognizing a sound through the bone-conduction auditory sense.

[EFFECT OF THE INVENTION]

According to the present invention, the bone-conduction speaker 10 includes a voice coil 30 secured to a base plate 14, a magnetic circuit including a yoke 22, a magnet 24 and an upper plate 26 and oscillating upwards and downwards, and a securing rivet 50 for securing

the yoke 22, a magnet 24 and an upper plate 26 together, and a mastoid positioned on a top surface of the securing rivet 50 and transferring a sound wave outwards, so that the sound wave is transferred to a bone such as a user's skull and the auditory nerves of a user is stimulated by the vibration of the bone. Accordingly, the hearing impaired can hear the sound as well as normal people. In addition, the bone-conduction speaker 10 is reduced to such a small size that many electronic appliances, such as a mobile phone, a radio, a headset phone, and a telephone, may include the bone-conduction speaker, and a sound leakage is sufficiently prevented to improve communication security.

Although the exemplary embodiments of the present invention have been described, it is understood that the present invention should not be limited to these exemplary embodiments but various changes and modifications can be made by one skilled in the art within the spirit and scope of the present invention as hereinafter claimed.

[CLAIMS]

[Claim 1] A bone-conduction speaker comprising:

a frame including a sidewall and a bottom, so that an inner space is defined by the sidewall and the bottom;

a protector including an opening at a central portion thereof, an inner peripheral portion of the protector being bonded to an upper portion of the sidewall of the frame;

a damper for reducing a frequency and an amplitude of a sound wave to thereby generate a vibration at a constant frequency, an outer end portion of the damper being interposed between the upper portion of the sidewall of the frame and the inner peripheral portion of the protector;

a yoke for focusing a magnetic flux, the yoke being positioned in the inner space and including a body portion for supporting an inner end portion of the damper and an extension portion formed together with the body portion and extending downwards from the body portion;

a magnet positioned at an inside of the extension portion of the yoke, an upper surface thereof making contact with a lower surface of the body portion;

an upper plate positioned at an inside of the extension portion of the yoke, a top surface of the upper plate making contact with a lower surface of the magnet, thereby forming a magnetic circuit together with the yoke and the magnet;

a secure member for securing the protector, the yoke, the magnet and the upper plate together, an upper portion thereof being exposed through the opening and a contact member that makes direct contact with a user's head being positioned on the upper portion of the secure member; and

a voice coil secured to a bottom of the frame and interposed between sidewalls of the upper plate and the magnet and the extension wall of the yoke.

[Claim 2] The bone-conduction speaker of claim 1, further comprising a colored film cap inserted into the opening and positioned on the contact member.

[Claim 3] The bone-conduction speaker of claim 1, wherein a terminal plate to which an electrical current is applied from a power source and a recessed portion to which a supplemental instrument is installed are positioned on the bottom of the frame, and a first end of a coil, which extends into an inside of the bone-conduction speaker through the bottom of frame, is secured to the terminal plate by a soldering and a second end of the coil is connected to a lower portion of the voice coil.

[Claim 4] The bone-conduction speaker of claim 3, wherein a central hole for controlling frequency response characteristics is positioned at a central portion of the bottom of the frame, and the recessed portion is positioned at an end portion of the bottom symmetrically to a portion at which the terminal plate is to be positioned with respect to the central hole.

[Claim 5] The bone-conduction speaker of claim 3, wherein the protector, the yoke, the magnet and the upper plate are sequentially arranged in a vertical direction and the secure member is inserted into a joint hole, which is formed through each of central portions of the protector, the yoke, the magnet and the upper plate, and both end portions of the secure member are compressed by a rivet joint, so that the protector, the yoke, the magnet and the upper plate are jointed together, and when an electrical current is applied to the terminal plate from the power source and then is applied to the voice coil from the terminal plate through the coil, a magnetic force generated between the voice coil, the upper plate, the magnet and the yoke may be periodically varied as an attractive force or a repulsive force, and the

periodical variation of the magnetic force from/to the attractive force to/from the repulsive force causes a periodic movement of the magnetic circuit in which the upper plate 26, the magnet 24 and the yoke 22 are formed together with one another on the condition that the voice coil 30 is secured to the terminal plate 11, thereby generating a vibration of the magnetic circuit while the damper on the upper surface of the yoke prevents a free oscillation of the magnetic field to thereby generate the vibration at a constant frequency, so that the vibration is transferred to the contact member that makes contact with a user's head and the vibration of the contact member is transferred to the head.